

A study of the health implications of mobile phone use in 8-14s

Jo Fowler & Jan Noyes

School of Experimental Psychology, University of Bristol, UK psjenf@bristol.ac.uk; j.noyes@bristol.ac.uk

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Abstract

Mobile phone use is increasing worldwide. The physical, cognitive and social health implications of mobile phone use in young users are considered. A survey of 168 children aged 8-11 and 136 children aged 11-14 is reported. Participants completed questionnaires about their mobile phone use with follow-up interviews to elicit more in depth information about reasons for using mobile phones. Findings suggest users are at risk of muscular skeletal problems from mobile phone use, radio frequency damage from storage of the phone on the body, particularly when the person is 'on the move', and impaired performance from multi-tasking and sleep disturbance. Since long term or heavy usage of mobile phones is an unknown factor, caution is needed with regard to the risks associated with these findings.

Keywords: Mobile phones; Smartphone; Text; Call; Impact; Health; Physical; Cognitive; Social

Un estudio de las implicaciones para la salud del uso del teléfono móvil en niños de 8-14

Resumen

El uso de teléfonos móviles está aumentando en todo el mundo. Se consideran aquí las implicaciones de esto para la salud física, cognitiva y social en usuarios jóvenes. Se presenta un estudio de 168 niños de edades 8-11 y 136 niños de edades 11-14. Los participantes completaron cuestionarios sobre su uso de teléfonos móviles y después fueron entrevistados para obtener más y profunda información acerca de las razones de uso. Los resultados sugieren que los usuarios de teléfonos móviles corren el riesgo de problemas musculares esqueléticos, daño de radiofrecuencia por mantener el teléfono sobre el cuerpo, sobre todo cuando la persona está "sobre la marcha", perjudicar su rendimiento en la multitarea y trastornos del sueño. Dado que uso a largo plazo o excesivo de los teléfonos móviles es un factor desconocido, es necesario tener precaución con respecto a los riesgos asociados con estos hallazgos.

Palabras clave: Teléfonos móviles; Teléfono inteligente; Texto; Llamada; Impacto; Salud; Física; Cognitiva; Social

1. Introduction

It is not uncommon to see people smoking in a film or a television programme made in the 1960s. Fifty years or so later, with the increase in scientific knowledge about the health consequences of smoking cigarettes, the habit has been relegated, to a large extent, to outdoors and most individuals who smoke are sensitive to subjecting others to the ill effects of the habit. This might be relevant to the current ambiguity surrounding the possible health hazards of mobile phone use [1]. With increased knowledge about the possible health dangers, our behaviour patterns may require change in a similar way. For example, the effect of radio frequency (RF)

radiation from mobile phones has led one brain specialist to describe the mobile phone as "the smoking gun of the twenty first century" [2].

The specialist who made this remark was referring to a mobile phone user who had been diagnosed with an acoustic neuroma, a brain tumour that grows on a nerve in the brain near the ear. The specialist found out that his patient was a regular mobile phone user. Evidence is not conclusive as yet, but many fear serious health risks from the use of mobile phones. Currently, the World Health Organisation classifies the RF effects of mobile phones as "possibly carcinogenic" [3].

The mobile phone has become a ubiquitous device in our daily lives. Usage has increased amongst all ages but in

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particular amongst younger users. A 2013 survey of American teenagers (12-17 year-olds) showed that 37% owned a smart phone [4]. This is an increase of 14% over a survey carried out by the Pew Centre in 2011, which recorded that 23% of this age group owned a smartphone [5]. In 2014, along with tablets, the mobile phone had become, after television, the most popular gadget among 6-15 year-olds in the United Kingdom (UK) [6]. However, mobile phone ownership and use in children has been the subject of limited research [7-9] and there is a need to find out more about how children use their phones. This study attempts to address this question in the light of the research literature on the risks of mobile phone use.

1.1. Physical health

A range of physical health risks has been shown to be linked to mobile phone use. Many studies have suggested a possible link between mobile phone RF effects, the incidence of brain tumours, and sleep disturbance. For example, it is generally recommended that mobile phones are not left to charge in the bedroom [10].

A recent publication by Mobile Wise, a group whose aim is to help young people use phones more safely, reported more than 200 scientific studies linking children's mobile phone use to serious health problems [10]. Children are potentially more susceptible than adults to the RF effects of mobile phone radiation because their brains have a higher fluid content, their skulls are thinner with skull thickness continuing to increase until they are about 18 years old [11]. As a result, the specific absorption rate (SAR) can be considerably higher for a child than for an adult [12]. It was found that Magnetic Resonance Imaging (MRI) scans of children aged 5 and 8 showed two times the SAR rate of adults [12]. Other studies have shown the same [13].

A meta-analysis of long-term mobile phone use found an association with ipsilateral glioma and acoustic neuroma. [14]. An ipsilateral glioma is a tumour on the same side of the head that the phone is used on. The risk of leukaemia [15,16] and parotid gland tumours in ipsilateral mobile phone users [17,18] has been suggested and there is also concern that the thyroid gland might be affected [19].

An Independent Expert Group first raised concerns about the potential vulnerability of children in 2000 [20]. Discussion continued, and in 2004 the World Health Organization held an expert workshop. The RF effects were considered not only for children but also for the pre-natal development of the embryo and the foetus as some studies have found a genotoxic effect. A meta-analysis of 101 publications of RF radiation showed that 49 reported a genotoxic effect while 42 did not [21]. In a comprehensive review of published scientific literature, an Environmental Working Group found 10 human studies that had identified a variety of changes in sperm exposed to cell phone radiation. In the findings, men who carried their phones in a pocket or on a belt were more likely to have lower sperm counts and/or more inactive or less mobile sperm [10].

Other possible health effects include: high frequency hearing loss [22]; eyestrain and blurred vision [23-25] and reduced fertility [26]. Musculoskeletal effects have also been

identified in users adopting unnatural postures. Symptoms include upper back and neck problems, flexed neck and right and left hand pain [27].

1.2. Cognitive health

Research has suggested that radio frequency radiation (RFR) might affect cognitive functioning. The results of computerised psychometric tests on mobile phone users aged 11-14 have shown impaired cognitive function [28]. Slower reaction to stimuli was associated with higher mobile phone use with reference to texting and voice calls. However, other studies have shown no cognitive effects [29, 30].

The Study of Cognition, Adolescents and Mobile Phones (SCAMP) commissioned by the UK Department of Health is currently assessing the cognitive abilities of 2,500 children, aged 11-12 in outer London [31]. The children will carry out computerised tasks designed to measure cognitive abilities such as memory and attention. The experiments of Hyman et al. [32] showed that attention was affected when students were walking and using their phones at the same time. It was found that mobile phone users were less than half as likely to notice an unusual activity (a uni-cycling clown) and it was suggested that inattentive blindness occurred as a result of a simple activity that required few cognitive resources. It took students 83 seconds to cross the campus area if they were on their phone compared to 79 seconds if they were not. Thus, the cognitive implications of mobile phone use are also important when users carry out a secondary task, such as driving or walking while texting, talking on the phone or listening to music.

1.3. Social health

Advantageous aspects of improved social communication from the use of the mobile phone have been well documented [33,34]. Users can gain a sense of freedom as a result of their ability to be contacted anywhere, any time. However, there have been negative health effects reported when voice calls and texts disrupt social interaction [35,36] or disturb sleep [37]. In extreme cases, mental distress and disruption of family and social relationships [38], stress and even addiction may occur [39]. Many users feel compelled to reply to texts and emails, constantly checking for the arrival of a message. Some of this seems to be an appropriate affordant of the nature of the technology but the level of compulsion and attachment can become problematic. Descriptions of mobile phone use from a study in Australia [40] that used criteria developed from Brown's behavioural addiction components [41,42] revealed symptoms of behavioural addiction. For example, many users were troubled by cognitive salience, occurring when the mobile phone overrides other thought processes such that, when trying to focus on one activity, they cannot stop thinking about their mobile.

Other social issues to do with mobile phones, particularly important for children, involve cyber-bullying and security. There are ways that parents can help their children in terms of internet safety, but unknown callers can contact children simply by ringing or texting them.

Notwithstanding possible health risks, the mobile phone

has been described as “permanently changing the way we work, live and love” [43, p.1]. It has also been claimed that mobile phones are “redefining careers, the family unit and social intercourse” [44, p.1]. This is thought to be due to its portability, multi-functionality and the affordance of constant accessibility and reachability. The latter has led to the employment of terms such as “always on” [34] and “perpetual contact” [45] as a way of describing the way users interact with this technology. Although this has created cognitive and social expansion, some health impacts have led to cognitive and social problems as well as physical ones. The aim of this paper is to identify any physical, cognitive or social health concerns provoked by mobile phone use in young users aged between 8 and 14.

2. Methods and materials

Questionnaire booklets about mobile phone use were developed and presented to young users to find out how they use mobile phones. Participants were 8-11 year-olds ($n=168$) and 11-14 year-olds ($n=136$). Boys and girls completed the questionnaires in small groups across six year groups in 11 schools in the South West of England. It took around 20 minutes to complete each questionnaire.

The questions included in the questionnaires are shown in Appendix 1.

It was decided to use questionnaires in order to gather data from a large sample of participants. A literature survey provided the background and several studies influenced the choice of questions [7,8,34,45]. These were adapted for the age of participants and a pilot study (unpublished) was carried out. Some questions were changed following the pilot study to make sure the 8-11 year-olds could fully understand the terminology. For example, technological gadget was changed to electronic gadget. The children themselves suggested this.

The questionnaires for 8-11 year-olds had only minor (but essential) differences from those designed for the 11-14 year-olds. For example, when asked what they used their mobile phone for, the 8-11 version made no reference to social networking sites like Facebook (because of the consent age for using Facebook) but these were mentioned in the version for 11-14 year-olds. The questionnaires included open-ended and multiple choice questions.

Interviews elicited in-depth information from participants. Interview questions are outlined in Appendix 2. The interviews were designed to encourage open-ended, undirected responses but it was also hoped that participants might give an indication of any physical discomfort they experienced as a result of using their phones. Children were interviewed in groups of three in order to create a sense of safety. This group size was also large enough to facilitate dynamic interaction between the participants but small enough for each individual's voice to be heard. The groups were facilitated by the researchers to ensure each child participated in the interviews.

Ethical procedures were followed; approval was given by the University of Bristol Ethics Committee. Participants could decide to leave the study at any point if they did not wish to continue. Information letters were also given to

parents/carers of all participants and parental/carer approval was gained with a signed consent form. Respondents had the opportunity to ask questions at any time and parents also had the opportunity to ask any questions they wished to the researchers.

3. Results and discussion

Descriptive statistics show that 95% of 8-11 year-olds have access to a mobile phone and that 66% own one. In the 11-14 age group, all but one participant owned a mobile phone (99%).

On average the 8-11 year-old participants make three to four calls a day ($M=3.5$, $SD=5.8$) with a range from 0 to 50. They send about 12 texts a day ($M=12.1$, $SD=29.0$) with a range from 0 to 201.

Results show that 11-14 year-olds make on average 21 calls a day ($M=3.4$, $SD=6.0$) with a range of 0 to 53. The 11-14 age group send about 50 texts a day ($M=49.6$, $SD=87$) with a range of 0 to 502.

3.1. Physical health

Over half of 8-11 year-old users said they use both their fingers and thumbs to operate their mobile phone (57%); however, 24% said they only use their thumbs and 16% said they use their fingers. It is the latter two groups that are most at risk of using singular, repetitive movements. The results for the 11-14 year-olds revealed that just under a third used their fingers and thumbs (30%). Very few participants used only their fingers (8%) but nearly half said they used only their thumbs (45%). In the interviews, one user said “it might hurt your fingers if you text too much”.

Texting was the most popular use of the mobile phone for young users (94% for 11-14 year-olds and 81% for 8-11 year-olds). Use of the thumb during texting can create pain at the bottom of the thumb or in the muscles of the thumb or wrist. When this becomes a severe and recurrent problem, it has been described as “Blackberry thumb” [46]. The evolutionary function of the thumb does not include repetitive usage in the way that texting requires. In the interviews, there were a few users who said they preferred to call rather than text because texting “can hurt your thumbs”. Another participant said “I don't want to hurt my thumb bones by texting”. To alleviate the problem, it is better to change between using fingers and thumbs when texting. It is also recommended that the pad of the thumb rather than the tip of the thumb is used to prevent an awkward, bent posture being created [47].

Participants were asked where they carried their phone when they were on the move. For 8-11 year-olds, the most common place was in a pocket (46%). Three quarters of 11-14 year-olds carried their phone in their pocket (75%).

It has been shown that mobile phone radiation can have a detrimental effect on sperm morphology and fertilisation potential in men from mobile phone proximity to the groin area [48]. Laboratory studies on animals have also found an association with mobile phone radiation and impaired female fertility [49] although causation has not been conclusively established.

In response to the question, “What do you like least about mobile phones?” seven participants commented on physical factors. Comments ranged from two participants remarking that “They are bad for your health”; another did not like “the fact they can be dangerous”, while a third referred to the fact that he thought “they give off electric magnetic stuff”. In contrast, one participant did not like “the shape of them” and felt that “if they were circular, they would be easier to hold”.

3.2. Cognitive health

Just over half of 11-14 year-olds reported that they dual task or multi-task while on their phone (55%). Multi-tasking activities vary but the most popular activity to use alongside their phone is the television (9%) followed by homework (8%) or playing on the Xbox (7%). Other multi-tasking activities include using a laptop, iPod, computer, walking, talking, eating, and listening to music, horse riding, or using Facebook or other social network sites. In the interviews, one participant said she preferred to text rather than call friends because “you can carry on with what you are doing”. Texting while walking, for example, can alter walking behaviour because of the increased cognitive demands placed on working memory and executive control during the performance of dual tasks, decreased availability of visual information of surroundings or modified mechanical demands associated with using the phone. In a study of 18-29 year-olds, analysis of gait performance showed that individuals walked slower and also displayed other postural effects [50].

3.3. Social health

Two-thirds of 8-11 year-olds liked to have their phones on all the time (67%) and more than three-quarters liked to be able to be text or called at all times (76%) whereas slightly more than three-quarters liked to be able to use a phone to keep in touch no matter wherever they were (79%). This was similar for 11-14 year-olds.

In the interviews, one respondent, referring to his phone said, “I couldn’t live without it”. This research shows that usage is greater for the 11-14 age group than for 8-11 year-olds.

Participants were asked about whether or not they kept their phones on when they went to bed: over half of 8-11 year-olds slept with a phone next to their bed (53%) and over a third left their phones on when they went to sleep (35%), while over two-thirds of the 11-14 year-old cohort slept with a phone next to their bed (72%) and left their phones on when they went to sleep (72%). This means that sleep disturbance from calls or texts during the night is likely. In the interviews, one participant expressed her annoyance at being woken up in the night, “Sometimes I’m asleep and it wakes me up. It vibrates and wakes me up”.

In response to the questionnaire question, “What do you like least about mobile phones?” the two most common themes identified for 8-11 year olds were cyberbullying (11%) and fear of strangers or people whom they did not know contacting them in “bad ways” (8%). Many voiced their concern about “inappropriate” contact and the fact that

“if you get caught by bad people you could be in serious trouble”. Cyberbullying remarks referred to the fact “that people will say rude things about you and it will say unknown” or you will “get sent a nasty text [sic.]”. There was less concern about these two issues, however, for the 11-14 year-olds, only a few participants mentioning cyberbullying issues (6%) or inappropriate contact (4%).

There were also comments from the 8-11 year-olds about the addictive nature of phones “they can addict you” and about how “so many people are obsessed with them”. Although this concern was expressed by only a few 8-11 year-olds (2%) obsession with their phones, and addiction, were of greater concern for the 11-14 year-olds (4%).

4. Summary

The mobile phone has had a significant impact on the ways in which people communicate and organise their lives. This research study has demonstrated the high involvement and investment of time in mobiles by this 8-14 age group. When matched against the literature on health hazards, the research shows that there are a number of physical, cognitive and social health concerns associated with young people’s use of mobile phones. This suggests that young users should be cautious about heavy use, especially with voice calls. Further, many of the long-term effects are not currently known. This study did not ask specifically about the length of time young users spend on mobile phones, although some evidence was gained in the interviews. Redmayne’s study [26] did gather information about the length of time young users spent on voice calls and concluded that if usage continued at the reported rate, many would be at risk of specific brain tumours by their mid-teens. As the multi-purpose function of the mobile phone continues to proliferate, an analysis of time spent on voice calls and other mobile functions could provide useful research data and guidance for the future.

An awareness of the health consequences of mobile phone use is paramount for increasing our knowledge and understanding. It should be noted that mobile phones now carry a UK Government health warning that highlights the scientific uncertainties concerning the long-term health effects of mobile use. Current government recommendations for children advise young users not to hold their mobile near their heads if they are making a voice call. It suggests texting, or using the mobile on speaker [51]. Advice also says young people should never leave their phones by their beds or under their pillows and never to keep them in their pockets. However, most young users, schools and parents are unaware of these guidelines.

Recommendations for further research could include finding out whether young users are taking advantage of opportunities to use hands-free equipment. Using mobile phones with headsets would ensure that they are kept away from children’s heads when talking on their mobiles, thus reducing the possible health risks from RF radiation. Another area of research could involve assessing the level of awareness of health-related issues with mobile phones amongst children, parents and schools. Active promotion and application, particularly of government recommendations for

mobile phone use, are necessary to encourage educational awareness and understanding, and to prevent harm.

References

- [1] Fowler, J. and Noyes, J., From dialling to tapping: Health considerations for young users of mobile phones, Proceedings of the International Symposium of Occupational Safety and Hygiene, Guimaraes, Portugal, pp. 115-117, 12-13 February, 2015.
- [2] Llewellyn-Smith, J., Are we ignoring the dangers of mobile phones? Telegraph, [online]. [date of reference January 6th of 2015]. Available at: www.telegraph.co.uk/news/health/10059834/Are-we-ignoring-the-dangers-of-mobile-phones.html.
- [3] International Agency for Research on Cancer (IARC), IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans, World Health Organisation press release [online]. No. 28, [date of reference June 2nd of 2011]. Available at: www.iarc.fr/en/media-centre/pr/2011/pdfs/pr28
- [4] Madden, M., Lenhart, A., Duggan, M. Cortesi, S. and Gasser, U., Pew research internet project, teens and technology, Teens and Technology. [online]. 2013, [date of reference June 16th of 2015]. Available at: <http://www.pewinternet.org/2013/03/13/teens-and-technology-2013/>
- [5] Smith, A., Pew internet and american life project, smartphone adoption and usage, [online]. 2011, [date of reference June 16th of 2015]. Available at: <http://itcnetwork.org/2011/11/Smartphone-adoption-and-usage-2011/>
- [6] OFCOM., The Communications Market. [online]. 2014, [Date of reference June 16th of 2015]. Available at: <http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/>
- [7] Geser, H., Pre teen cell phone adoption: Consequences for later patterns of phone usage and involvement, sociology of the mobile phone, [online]. [date of reference June 10th of 2015]. Available at: http://socio.ch/mobile/t_geser2.htm
- [8] Madell, D. and Muncer, S.J., Control over social interaction: An important reason for young people's use of the internet and mobile phones for communication. *Cyberpsychology & Behaviour*, 10(1), pp. 137-140, 2007. DOI: 10.1089/cpb.2006.9980
- [9] Mezei, G., Benyi, M. and Muller, A., Mobile phone ownership and use among school children in three Hungarian cities. *Bioelectromagnetics*, 28, pp. 309-315, 2007. DOI: 10.1002/bem.20270
- [10] Mobilewise, Mobile phone health risks: The case for action to protect children, [online]. [date of reference January 8th of 2015]. Available at: www.mobilewise.org
- [11] Ghandi, O.P., Lazzi, G. and Furse, C.M., Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz, *IEEE Trans Microwave Theory Technique*, 44(10), pp. 1884-1897, 1996. DOI: 10.1109/22.539947
- [12] De Salles, A.A., Bulla, G. and Rodriguez, C.E., Electromagnetic absorption in the head of adults and children due to mobile phone operation close to the head. *Electromagnetic Biology & Medicine*, 25(4), pp. 349-360, 2006. DOI: 10.1080/15368370601054894
- [13] Peyman, S., Chetrit, A. and Jarus-Hakuk, A. et al., Cellular phone use and risk of benign and malignant parotid tumors – A nationwide case control study. *American Journal Epidemiology*, 167(4), pp. 457-467, 2008. DOI: 10.1093/aje/kwm325
- [14] Hardell, L., Carlberg, M., Soderqvist, F. and Hansson-Mild, K., Meta-analysis of long-term mobile phone use and the association with brain tumours. *International Journal of Oncology*, 32, pp 1097-1103, 2008. DOI: 10.3892/ijo.32.5.1097
- [15] Kauffman, D.W., Anderson, T.E. and Issaragrisil, S., Risk factors for leukaemia in Thailand. *Annals of Haematology*, 88(11), pp. 1079-1088, 2009. DOI: 10.1007/s00277-009-0731-9
- [16] Cooke, R, Laing, S. and Swerdlow, A.J., A case-control study of risk in leukaemia in relation to mobile phone use. *British Journal of Cancer*, 103, pp. 1729-1735, 2010. DOI: 10.1038/sj.bjc.6605948
- [17] Sadetaki, S., Chetrit, A., Jarus-Hakak, A., et al., Cellular phone use and risk of benign and malignant parotid gland tumors – A nationwide case control study. *American Journal of Epidemiology*, 167(4), pp. 457-467, 2009. DOI: 10.1093/aje/kwm325
- [18] Loon, S., Ahlbom, A., Christensen, H.C., et al., Mobile phone use and risk of parotid gland tumour. *American Journal of Epidemiology*, 164(7), pp. 637-643, 2009. DOI: 10.1093/aje/kwj242
- [19] Tinnisword, A.D., Furse, C. and Ghandi, O.P., Power deposition in the head and neck of an anatomically based human model for plane wave exposures. *Physics in Medicine & Biology*, 43, pp. 2361-2378, 2008. DOI: 10.1088/0031-9155/43/8/026
- [20] Stewart, W., Chairman, mobile phones and health, a report of the independent expert group on mobile phones, Report of the group of the Stewart Report. Chilton, UK: IEGMP Secretariat, [online]. [date of reference January 3rd 2015]. Available at: www.iegmp.org.uk/report/index.html
- [21] Ruediger, H.W., Genotoxic effects of radiofrequency electromagnetic fields. *Pathophysiology*, 16(2-3), pp. 67-69, 2009. DOI: 10.1016/j.pathophys.2009.02.002
- [22] Velayutham, P., Govindasamy, G.K., Raman, R., Prepageran, N. and Ng, K.H., High frequency hearing loss among mobile phone users. *Indian Journal of Otolaryngology and Head & Neck Surgery*, 66(Suppl.1), pp. 169-72, 2014. DOI: 10.1007/s12070-011-0406-4
- [23] Balik, H.H., Turgut-Balik, D., Balikci, K. and Ozcan, I.C., Some symptoms and ocular sensations experienced by long term users of mobile phone. *Pathologie Biologie (Paris)*, 53(2), pp. 88-89, 2005. DOI: 10.1016/j.patbio.2004.03.012
- [24] Kucer, N., Some ocular symptoms experienced by users of mobile phones. *Electromagnetic Biology Medicine*, 27(2), pp. 205-209, 2008. DOI: 10.1080/15368370802072174
- [25] Bababekova, Y., Rosenfield, M., Hue, J.E. and Huang, R.R., Font size and viewing distance of hand held smart phones. *Optometry & Vision Science*, 88(7), pp. 795-797, 2011. DOI: 10.1097/OPX.0b013e3182198792
- [26] Redmayne, M., New Zealand adolescents' cell phone and cordless phone user habits: Are they at increased risk of brain tumours already? A cross-sectional study. *Environmental Health*, 12(5), 10 P. 2013.
- [27] Gustaffson, E., Johnson, P.W., Lindegard, A. and Hagberg, M., Technique, muscle activity, kinematic differences in young adults texting on mobile phones. *Ergonomics*, 54, pp. 477-487, 2011. DOI: 10.1080/00140139.2011.568634
- [28] Abramson, M.J., Benke, G.P., Dimitiadis, C., Inyang, I.O., Sim, M.R., Wolfe, R.S. and Croft, R.J., Mobile telephone use is associated with changes in cognitive functions in young adolescents. *Bioelectromagnetics*, 30, pp. 678-686, 2009. DOI: 10.1002/bem.20534
- [29] Preece, A.W., Goodfellow, S., Wright, M.G., Butler, S.R., Dunn, E.J., Johnson, Y., Manktelow, T.C. and Wesnes, K., Effect of 902 MHz mobile phone transmission on cognitive function in children. *Bioelectromagnetics*, 26(7), pp. 138-143, 2005. DOI: 10.1002/bem.20128
- [30] Besset, A., Espa, F., Dauvilliers, Y., Billard, M. and de Seze, R., No effect on cognitive function from daily mobile phone use. *Bioelectromagnetics*, 26(2), pp.102-108, 2005. DOI: 10.1002/bem.20053
- [31] Welland, K., Researchers to study whether mobile phones affect teenage brains, [online]. [date of reference December 10th of 2014]. Available at: <http://www.reuters.com/article/us-health-mobilephone-idUSKBN0DZ1YO20140520>
- [32] Hyman, I.E., Boss, S.M., Wise, K.E. and Caggiano, M., Did you see the unicycling clown? Inattention blindness whilst walking and talking on a cell phone. *Applied Cognitive Psychology*, 24(5), pp. 597-607, 2009. DOI: 10.1002/acp.1638
- [33] Ling, R. and Yttri, B., Hyper-coordination via mobile phones in Norway, in: Katz, J.E. and Aakhus, M. (eds.), *Perpetual contact: Mobile communication, private talk, public performance*. Cambridge University Press, Cambridge UK, 2002, pp. 139-169. DOI: 10.1017/CBO9780511489471.013
- [34] Baron, N.S., Talk about texting: Attitudes towards mobile phones, Proceedings of the London Workshop of Writing, University of London, pp. 207-225, 2009.
- [35] Humphreys, L., Cellphones in public: Social interactions in a wireless era. *New Media & Society*, 7(6), pp. 810-833, 2005. DOI: 10.1177/1461444805058164

- [36] Hubbard, P., A good night out? Multiplex cinemas as sites of embodied leisure. *Leisure Studies*, pp. 255-272, 2007.
- [37] Thomee, S., Harenstam, A. and Hagberg, M., Mobile phone use and stress, sleep disturbances and symptoms of depression among young adults – A prospective cohort study. *BMC Public Health*, [online]. 11(66), [date of reference November 3rd of 2014]. Available at: <http://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-11-66>
- [38] Beraney, M., Oberst, U., Carbonell, X. and Chamorro, A., Problematic Internet use and mobile phone use and clinical symptoms in college students: The role of emotional intelligence. *Computers in Human Behaviour*, 25, pp. 1182-1187, 2009. DOI: 10.1016/j.chb.2009.03.001
- [39] Arbitron Inc. and Jacobs Media. [Guest Blog]: The impact of smartphones on American life, [online]. 1-3, [date of reference July 14th of 2013]. Available at: <http://www.redcrowmarketing.com/2012/03/17/guest-blog-the-impact-of-smartphones-on-american-life/>
- [40] Walsh, S.P., White, K.M. and Young, R.M., Over connected? A qualitative exploration of the relationship between exploration of the relationship between Australian youth and their mobile phones. *Journal of Adolescence*, 31, pp. 77-92, 2008. DOI: 10.1016/j.adolescence.2007.04.004
- [41] Brown, R.I.F., Some contributions of the study of gambling to the study of other addictions, in: Eadington, W.R. and Cornelius, J.A. (eds.), *Gambling behaviour and problem gambling*, Institute for the Study of Gambling and Commercial Gaming, University of Nevada, Reno, 1993. pp. 241-172.
- [42] Brown, R.I.F., A theoretical model of the behavioural addictions – applied to offending, in: Hode, J.E., McMurrin, M. and Holin, C.R. (eds.), *Addicted to crime*. Chichester, UK Wiley, 1997.
- [43] Brown, A., Cell phone usage, [online]. [date of reference July 12th of 2013]. Available at: <http://www.compukiss.com/articles/cell-phones-usage.html>
- [44] Arbitron Inc. & Jacobs Media [Guest Blog]., The Impact of Smartphones on American Life, [online].1-3, [date of reference July 6th of 2013]. Available at: <http://redcrowblog.blogspot.com/2010/01/guest-blog-impact-of-smartphones-on.html>
- [45] Kasesniemi, E.L. and Rautaninen, P., Mobile culture of children and teenagers in Finland, in: Katz, J.E. and Aakhus, M. (eds.), *Perpetual Contact: Mobile communication, private talk, public performance*. Cambridge University Press, Cambridge UK, 2002, pp. 35-57. DOI: 10.1017/CBO9780511489471.014
- [46] O'Sullivan, B., Beyond Blackberry thumb, *CMAJ*, 185(4), E185-6, 2013. DOI: 10.1503/cmaj.109-4395
- [47] Tips for musculoskeletal injuries, [online]. [date of reference October 3rd of 2014]. Available at: <http://physioadvisor.com>
- [48] Falzone, N., Huyser, C., Becker, P., Leszczynski, D. and Franken, D.R., The effect of pulsed 900-MHz GSM mobile phone radiation on the acrosome reaction, head morphometry and zona binding of human spermatozoa, *International Journal of Andrology*, pp. 20-26, 2011. DOI: 10.1111/j.1365-2605.2010.01054.x
- [49] Gul, A., Celebi, H. and Ugras, S., The effects of microwave emitted by cellular phones on ovarian follicles in rats. *Archives of Gynecology and Obstetrics*, 31(1), pp. 34-51, 2009. DOI: 10.1007/s00404-009-0972-9
- [50] Schabrun S.M., van den Hoorn, W., Moorcroft, A., Greenland, C. and Hodges, P.W., Texting and walking: Strategies for postural control and implications for safety. *PLoS One*, 9(2), 2014. DOI: 0.1371/journal.pone.0084312
- [51] Government Advice, Wired child, protecting our children from wireless technology, [online]. [date of reference April 20th of 2016]. Available at: wiredchild.org/government-alias.html

Appendix 1: Questions relating to Health Issues from the Mobile Phone Use Questionnaire

1. What do you like least about mobile phones?
2. Do you get chance to use a mobile phone?
3. Do you own a mobile phone?
4. When on the move where do you keep a mobile phone? – in a bag; in a pocket; slung on a belt; in my hand; other, please say where you keep a mobile phone.
5. Do use your fingers or thumbs when you use a mobile phone? – fingers; thumbs; fingers and thumbs; other, please say what you use
6. When you use your mobile phone do you do anything else at the same time?
7. If yes, please say what other task you carry out.
8. How many calls do you make on a mobile in a day?
9. How many texts do you make on a mobile in a day?
10. Do you like to keep your phone on? All the time, to keep in touch no matter where I am, to sleep with it next to my bed, to sleep with my phone on or to turn it off when I go to bed.
11. What do you use a mobile phone for? Calling, texting, exchanging photos, recording a video, exchanging a video, using the internet, email, games, downloading ring tones, downloading apps, playing music, setting my alarm, Twitter, Facebook, Blogging, other Social networks.
12. Please tick what year group you are – Year 4; 5; 6; 7; 8; 9 (Note. Year 4 = 8-9 years; Year 5 = 9-10 years; Year 6 = 10-11 years; Year 7 = 11-12 years; Year 8 = 12-13 years; Year 9 = 13-14 years.)
13. Please tick to say if you are a girl or a boy – girl; boy.

Appendix 2: Interview questions about Mobile Phone Usage (which were found to indicate health-related issues).

1. Please can you tell me what you think about mobile phones?
2. Why do you think the mobile phone has become such an important part of everyday life?
3. Do you prefer to text or call?
4. What makes you decide to text rather than call?
5. What makes you decide to call rather than text?

J. Fowler, is MSc, BSc. is a doctoral student in Human Factors Psychology at the University of Bristol, UK. She worked on a project on the role of image for speech intelligibility for mobile phones at the University of Lulea, Sweden (1992). She has been a Human Factors Lecturer on the BSc in Product Design at the University of East London (1995-6) and is a Student Member of the Institute of Ergonomics and Human Factors. In June 2015, she reached the semi-finals of the 3MT competition at the University of Bristol. The 3MT competition is an academic competition in which 35 UK institutions take part and which encourages contestants to bring their research to life in an engaging way for the lay person.
ORCID: 0000-0001-6894-6407

J. Noyes, is DSc, PhD, BSc. is a professor of Human Factors Psychology at the University of Bristol, UK. She is a Fellow of the Institute of Ergonomics and Human Factors, and an Associate Member of the British Psychological Society and the Institution of Engineering and Technology (formerly the IEE – Institution of Electrical Engineers). In 1999, she was awarded the Otto Edholm medal for her significant contribution to the application of ergonomics. She has authored around 250 publications in the field of human factor aspects of interface design, including seven books, and was awarded the IEE Informatics Premium Award in 1998 for her paper on 'Engineering psychology and system safety'. She was also Chair of the 1999 and 2001 IEE People In Control (PIC) conferences, and has been/is on the Editorial Boards of six journals.
ORCID: 0000-0003-0287-8573